REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
25-06-2001

2. REPORT DATE Type
FINAL

3. DATES COVERED *(From - To)*
June 1997 - May 2001

4. TITLE AND SUBTITLE
Biological Time Scales in Acoustic Backscatter from Littoral Bottom Boundary Layers

5a. CONTRACT NUMBER

5b. GRANT NUMBER
N00014-97-1-0643

5c. PROGRAM ELEMENT NUMBER

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

6. AUTHOR(S)
Dr. Peter A. Jumars

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
School of Oceanography
University of Washington
Box 357940
Seattle, WA 98195-7940

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217-5660

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
There are no restrictions to distribution

20010629 027

13. SUPPLEMENTARY NOTES

14. ABSTRACT
We used time-series analysis with data from acoustic instruments, i.e., TAPS (Tracor Acoustic Profiling System) and BAMS and XBAMS (two versions of APL-UW's bottom-mounted sonar system) from several different localities. We supplemented acoustic data with trap samples and plankton tows timed to capture specemins to allow us to identify causes of acoustic events. In addition, we characterized bacterial and biopolymer coverage of sediments because of the potential effects of these viscoelastic materials on frictional loss between grains.

15. SUBJECT TERMS
benthic, backscatter. TAPS, BAMS, XBAMS, time-series analysis, acoustic backscatter, mysids, emergence behavior

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
U	U	U	UU	3	Dr. Peter A. Jumar
					19b. TELEPONE NUMBER *(Include area code)* 207-563-3146x242

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI-Std Z39-18

FINAL REPORT

Grant #: N00014-97-1-0643 (AASERT)

PRINCIPAL INVESTIGATOR: Dr. Peter A. Jumars

INSTITUTION: University of Washington

PROJECT TITLE: Biological time scales in acoustic backscatter from littoral bottom boundary layers.

REPORTING PERIOD: 1 June 1997 - 31 May 2001

AWARD PERIOD: 1 June 1997 - 31 May 2001

OBJECTIVES: The broad objectives of this research were to characterize benthic and near-bottom contributions of biology to acoustic backscatter at high frequency (≥ 40 kHz), focusing on the time domain.

APPROACH: We used time-series analysis with data from acoustic instruments, i.e., TAPS (Tracor Acoustic Profiling System) and BAMS and XBAMS (two versions of APL-UW's bottom-mounted sonar system) from several different localities. We supplemented acoustic data with trap samples and plankton tows timed to capture specimens to allow us to identify causes of acoustic events. In addition, we characterized bacterial and biopolymer coverage of sediments because of the potential effects of these viscoelastic materials on frictional loss between grains.

ACCOMPLISHMENTS: The AASERT grant helped us complete analysis of a six-day TAPS record (Kringel et al., in manuscript) showing a shallow-water scattering layer. We identified it to be caused by vertically migrating mysids that spend daylight hours on or in the bottom or near-bottom turbid layers. We have subsequently found this phenomenon to be nearly universal, but with very interesting local variations. In particular, in coastal embayments with strong tides, there is strong tidal modulation of nightly emergence, with the highest per-hour rates of emergence corresponding with the highest shoreward velocities, suggesting a retention function. This emergence dominates backscatter from volume reverberation near the seabed, but it does not appear to dominate the rate of change of backscatter from the seabed. The latter usually reaches a peak at midday, and we have reason to believe, particularly from the SAX99 experiment, that pock marking of the bottom by feeding fish may be the dominant cause. Fish disperse away from the bottom at night, but collect in patches during the day. On the bacterial issue, we found that bacteria had very constant abundances per unit of volume of pore water (one billion per cubic centimeter; Schmidt et al. 1998), but that they were not concentrated at grain-grain contacts.

CONCLUSIONS: Our tentative conclusion is that emergence of backscattering fauna is a widespread coastal phenomenon, timed to prevent loss of individuals to visual predators. Visual predators, in turn, may dominate the rate of change in backscatter from the seabed and may set equilibrium seafloor roughness on a small scale (0.5-3 cm). At the bacterial scale, diffusional limitation provides the simplest explanation of bacterial abundance and spatial location (Schmidt and Jumars 2001).

SIGNIFICANCE: These biological phenomena set the backscatter environment for mine hunting. From the standpoint of mine hunting, the least biological noise near the seabed occurs after sunset and before sunrise, quite unlike the acoustic problem of hunting targets in the upper ocean. From the biological viewpoint, acoustics is providing data on near-seabed and seabed processes on unprecedented scales, i.e., short intervals and large spatial extents. Although they are not concentrated at grain-grain contacts, bacteria and their polymers are abundant enough potentially to significantly affect sound transmission by altering mechanical properties (i.e., friction between grains).

PUBLICATIONS: The AASERT grant has contributed in varying measure to a number of publications and manuscripts:

Schmidt, J.L., J.W. Deming, P.A. Jumars and R.G. Keil. 1998. Constancy of bacterial abundance in marine sediments. *Limnol. Oceanogr.* **43**: 976-982.

Schmidt, J.L. and P. A. Jumars. 2001. Clonal fitness of bacteria predicted by analog modeling. *BioScience,* in press.

Self, R.F.L., P. A'Hearn, P.A. Jumars D.R. Jackson, M.D. Richardson and K.B. Briggs. Effects of macrofauna on acoustic backscatter from the seabed: field manipulations in West Sound, Orcas Island, WA, USA. *J. Mar. Res.,* submitted

Kringel, K., P.A. Jumars and D.V. Holliday. A shallow scattering layer: high-resolution acoustic analysis of nocturnal vertical migration from the seabed.*Limnology and Oceanography,* in manuscript.

CONTRIBUTIONS TO HUMAN RESOURCE DEVELOPMENT: This AASERT grant supported the M.S. work of Keli Kringel and Ph.D. work of Jill Schmidt at the University of Washington, and it has begun the M.S. work of Heather Uhden and Leslie Harris at the University of Maine. Both of the latter two are continuing to work on emergence behavior under other funding.